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(54) Method of controlling power on forward link in a cellular CDMA system

Verfahren zum Steuern der Leistung auf einer Abwärtsstrecke in einem zellularen CDMA-System

Procédé de commande de la puissance de la liaison vers l'avant dans un système cellulaire AMDC

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Description

[0001] The present invention relates generelly to techniques In trensmission power control of base stetions in a CDMA (code division multiple access) cellular system using spreed spectrum techniques. More specificelly, the present Invention reletes to e power control method on forward links (viz., bese stetlon to mobile unit links) in e CDMA celluler system In order to Increase cepacity of the overell system.

[0002] As is well known in the ert, In e CDMA system, ell users trensmit simultaneously end et the same frequency. The transmitted signels occupy the entire system bendwidth, end code sequences, which are orthogonel, are used to separete one user from enother. Thet is, each user Is essigned e unique code sequence. The use of the seme frequency in the overell system indicates that no "hendoff" from one frequency to enother is needed es In FDMA (frequency division multiple eccess) end TDMA (time division multiple eccess) systems. This Is celled a soft hendoff thet is disclosed in US-A-5,101,501 by way of example.

[0003] In e CDMA system, there Is no distinct limit on the number of users. The system performence for ell users degredes gredually es the number of ective users increeses. More specifically, mobile units In the CDMA system transmit Independently (viz., esynchronously) from eech other. This means thet their signels errive rendomly et the bese station and therefore, the crosscorrelation between these randomly, arrived signels is not zero and thus ceuses interference.

[0004] The major difficulty with CDMA Is a so-celled "neer-far effect", which occurs when e week signal received at the bese station from e distant mobile unit is overpowered by e strong signal from e neerby Interferer. To reduce the neer-far effect, power control on reverse links (viz., mobile unit to base stetion links) Is necessary.

[0005] Additionelly, the system cepecity is expanded by power control on the forward links (viz., base station to mobile unit links). One example of such power control on the forwerd link Is disclosed in JP-A-7-38496. According to this conventionel technique, each of the mobile units In e given cell receives e pilot signal from the cell's bese stetion, meesures e signel-to-noise (S/N) retio using the pilot signal received, end then Informs the base station of the meesurement results. The bese station responds to the measurement results end controls the transmission power on the forwerd link of each mobile unit. Thus, the S/N retios et the mobile units within the cell are Improved and approech e predetermined level (viz, roughly equelized). As e result, a low level of Interference is echieved et eech mobile unit.

[0006] This conventional technique, however, has suffered from a drawback. Thet is, when a S/N ratio at e given mobile unit is lowered due to Increase In the number of the active users In the cell, the base stetion is responsive to the reduced S/N ratio end reises the power on the forwerd link to the given mobile unit. This In turn undesirebly lowers the S/N retio at eech of other mobile units, with the result thet the S/N ratio of the first base stetion agein is lowered. This cycle is repeated end eventually the power of eech forwerd link of many mobile units undesirably is raised to the maximum value.

[0007] Further, it tekes e reletively long time until the lowering of Interference Is cerried out efter the meesurement of the S/N ratio. Therefore, during the long feedbeck time, the S/N retio meesured hes undesirably chenged. In such e cese, e precise control is no longer expected.

[0008] The erticle "Tuning the macrodiversity performence In a DS- CDMA system" by T. Andersson, 1994 IEEE Vehiculer Technology Conference, 8 June 1994, peges 41-45, discloses pilot strength meesurements at e mobile unit of all base stations connected to said mobile station (ective set). The trensmitted signel power of the bese stetions In the active set is then edjusted using the obtained meesurements.

[0009] It is therefore en object of the present invention to provide e method of echieving e low level of Interference, especially in the vicinity of a cell boundery, even if the number of ective users Increases, whereby It is possible to keep constant the system performance for all users. This object Is achieved with the feetures of the cleims.

[0010] One aspect of the present invention resides In e method of controlling transmission power of a plurelity of bese stetions associeted with a mobile unit In a CDMA (code division multiple eccess) celluler system, the mobile unit communiceting with one bese station emong the plurality of base stetions, the method comprising the steps of: (e) measuring, et the mobile unit, power of eech of pilot signals respectively trensmitted from the plurality of bese stetions; (b) edvising the one bese station of Informetion ebout a meesured power velue of eech of the pilot signels; (c) determining, at the one base stetion, e first power control coefficient which is a ratio of totel pilot signel power velues of the plurality of base stations, other than seid one bese stetion, to e pilot signal power value of the one base stetion; end (d) controlling the trensmission power of eech of the plurality of base stetions using the first power control coefficient.

[0011] The features end edventeges of the present Invention will become more cleerly eppreciated from the following description taken In conjunction with the eccompenying drawings in which like elements ere denoted by like reference numerels end In which:

Fig. 1 is a sketch schematically showing a plurality of cells, base stetions, etc. provided In e CDMA celluler system;

Fig. 2 Is e time slot format of one frame for ecquiring pilot signal power on forward links of base stetions;

Figs. 3, 4A and 4B ere eech flow chart which shows steps which characterize e first embodiment of the present invention;

Figs. 5A and 5B ere eech flow chert which shows

steps which characterize a second embodiment of the present invention;

Fig. 6 is a flow chart which shows steps which characterize a third embodiment of the present invention;

Figs. 7A, 7B and 8 are each flow chart which shows steps which characterize a fourth embodiment of the present invention; and

Figs. 9A and 9B are each flow chart which shows steps which characterize a fifth embodiment of the present invention.

[0012] Referring to Fig. 1, there are shown only three cells 10, 12, and 14 which respectively include base stations BS1, BS2, and BS3. Further, as shown, another three base stations BS4-BS6 are respectively assigned to the other three cells (not shown). As is well known in the art, all the base stations in the system, including BS1-BS6, are coupled to a MTSO (mobile telephone switching office) 16, which supervises the overall operation of the system and which is in turn coupled to a public switched telephone network. Still further, two mobile units 18 and 20 are shown in Fig. 1. The mobile unit 18 is located in the vicinity of the boundary between the cells 10 and 12 and simultaneously communicates with two base stations BS1 and BS2 in order to attain the above mentioned soft handoff. However, it is to be noted that the mobile unit 18 in fact establishes a speech channel with either BS1 or BS2. It is assumed that the other mobile unit 20 is not located in the vicinity of a cell boundary and thus keeps communication only with the base station BS1.

[0013] The present invention is not directly concerned with a handoff operation but directed to effectively achieve a low level of interference in the vicinity of a cell boundary. Therefore, the system capacity can markedly be increased (viz., the number of active users can be increased without inducing degradation of signal quality).

[0014] Each of the base stations in the system constantly transmits a pilot signal the transmission power of which may vary depending on the cell size. However, in the instant disclosure, it is assumed that each base station radiates the corresponding pilot signal with a predetermined (constant) power for the sake of simplifying the description. Each pilot signal is assigned a unique code and thus, it is possible for the mobile unit to discriminate which base station generates the pilot signal.

[0015] On the other hand, each mobile unit is provided with a device for measuring the strength of each of the pilot signals arriving at the mobile unit. More specifically, the mobile unit selectively acquires a predetermined number of pilot signals using codes which are applied thereto from a currently communicating base station.

[0016] Fig. 2 is a diagram showing a pilot signal acquiring (or measuring) frame which consists of six time slots 1-6 in this instance. Each mobile unit acquires one pilot signal during one time slot and thus, is able to cyclically receive a total of six different pilot signals on a frame-by-frame basis in this particular case. The mobile unit typically measures the power (viz., signal strength) of one pilot signal during one time slot. If more than six pilot signals should be received at the mobile unit, the frame length can be expanded to meet the requirement. The instantaneous power of the pilot signal typically varies drastically and thus, it is a current practice to average the power over a sufficiently long time. Throughout the instant disclosure, the power of a pilot signal means an average value.

[0017] It is assumed that a mobile unit has already established a speech channel with a given base station (sometimes referred to as a current base station). In this case, the mobile unit receives, from the current base station, information indicating a set of neighboring base stations. Based on this information, the mobile unit measures the power of each of the pilot signals transmitted from the neighboring base stations in addition to the power of the pilot signal from the current base station.

[0018] A first embodiment of the present invention will be described with reference to Figs. 3, 4A and 4B.

[0019] In Fig. 3, at step 22, the mobile unit checks to determine if the current base station should be changed (viz., handoff). The instruction of changing the current base station (denoted by BS_0) is advised from the current base station itself. If the current base station should be changed, the routine goes to step 24 whereat a new base station is advised together with a new set of neighboring base stations BSi (i=1, 2, ..., n)(n is five in the case shown in Fig. 1 for example). On the other hand, if the answer is negative at step 22, the routine proceeds to step 26. At this step 26, the power of each of the pilot signals on the forward link (viz., inbound link or base station to mobile unit link) in connection with the base stations BS_0 and BSi are measured. Following this, at step 28, each of the measured pilot signal's power values is compared with a predetermined value (T1) so as to select the values exceeding T1. The power values thus selected are denoted by B_0 and Bi (i=1, 2, ..., m ($m \leqq n$)) wherein B_0 is the power value of BS_0 and Bi are power values of BSi. Thereafter, at step 30, the power values B_0 and Bi are transmitted to the current base station BS_0.

[0020] Figs. 4A and 4B show steps which are implemented at the current base station. At step 32, the base station receives the power values B_0 and Bi from the mobile unit. Thereafter, at steps 34 and 36, a check is made to determine if the current base station should be changed based on the power values B_0 and Bi received at step 32. If a change of the base station is to be imptertented, the data indicating the new base station (denoted by BS'_0) is stored in the current base station. If a change of the current base station is not required, the routine directly goes to step 38 at which a handoff indicator Gh is calculated as follows. In this case, Bi are rewritten by Qi

$$Gh = (Q_1 + Q_2 + \dots + Q_m)/B_0 \quad (1)$$

Following this, at step 40, the power values B_0 and Qi, exceeding a second predetermined value (T2), are selected. The selected power values are denoted by B_0 and Qi (i=1, 2, ..., k (k≦m)). It is to be noted that the value B_0 is selected in that this value is the largest one. Following this, a power control coefficient R is calculated as follows at step 42.

$$R = (Q_1+Q_2+\dots+Q_k)/Gh\text{-}B_0 \quad (2)$$

Therefore, since R can be rewritten using equation (1) as follows.

$$R = (Q_1+Q_2+\dots+Q_k)/(Q_1+Q_2+\dots+Q_m) \quad (3)$$

[0021] Thereafter, the routine goes to the steps of Fig. 4B wherein if the current base station should not be changed (determined at step 43a) the routine goes through steps 43b and 44 to step 32 (Fig. 4A). On the other hand, if the current station should be changed, the routine goes through steps 46, 48 and 50 and is terminated.

[0022] More specifically, as shown in Fig. 4B, at step 43b, the base station advises the MTSO of the power control coefficient R, and at step 44, the base station changes the transmission power thereof to $R \cdot P_0$ (P_0 is a reference transmission power). On the other hand, if an answer is positive at step 43a, the routine goes to step 46 at which the base station advises the MTSO of the new station. Thereafter, at step 48, the base station receives a new set of neighboring base stations associated with the new base station. Subsequently, at step 50, the base station advises the mobile unit of the new base station and the new neighboring base stations.

[0023] A second embodiment of the present invention will be described with reference to Figs. 5A and 5B.

[0024] As shown in Fig. 5A, steps 32' to 40' are identical to step 32 to 40 and hence further descriptions thereof are omitted for brevity. The second embodiment features that the power control coefficient R is derived using total transmission power values (Pi) of the base stations and the corresponding power values Qi. In Fig. 5A, Pmax indicates the maximum allowable power value of each base station. More specifically, at step 52, the base station receives, from the MTSO, a total transmission power value of each of the base stations associated with Qi (the total transmission power values is denoted by Pi). Thereafter, the routine goes to step 54 whereat the power control coefficient R is calculated as follows: $R=(P_1Q_1+P_2Q_2+\dots+P_kQ_k)/(Gh\cdot Pmax\cdot B_0)$. On the other hand, the power control coefficient R should be in a range between previously determined minimum and maximum values (Rmin and Rmax). The manner of defining the coefficient R between Rmin and Rmax is shown in Fig. 5B. As shown in Fig. 5B, at step 56, a check is made to determine if R>Rmax. If the answer at step 56 is affirmative, the routine goes to step 58 whereat R is replaced with Rmax, after which the routine proceeds to the flow chart of Fig. 4B. On the contrary, if the answer at step 56 is negative, the routine goes to step 60 whereat a further check is made to determine if R<Rmin. If the answer at step 60 is affirmative, the routine goes to step 62 whereat R is replaced with Rmin, after which the routine proceeds to the flow chart of Fig. 4B. On the contrary, if the answer at step 60 is negative, the routine directly goes to the flow chart of Fig. 4B. After implementing either step 62 or step 58, the routine goes to the program which is exactly identical to that shown in Fig. 4B.

[0025] A third embodiment of the present invention will be described with reference to Fig. 6.

[0026] As shown in Fig. 6, steps 32' to 38' are identical to step 32 to 38 and hence further descriptions thereof are omitted for brevity. The third embodiment features that the number of pilot signals (m in this case) is checked for whether or not the number exceeds the previously determined maximum number of pilot signals (Nmax) If m>Nmax, at step 70, steps 72 and 74 are implemented and the routine proceeds to step 76. Otherwise, the routine implements steps 78 and 80 and then goes to step 76. After carrying out step 76, the routine goes to the program which is exactly identical to that shown in Fig. 4B.

[0027] A fourth embodiment of the present invention will be described with reference to Figs. 7A, 7B and 8. This embodiment is to carry out, at the mobile unit, the steps which are executed in the current base station in the first embodiment. Therefore, the burden on the base station can be reduced.

[0028] As shown in Fig. 7A, steps 22' to 26' are identical to steps 22 to 26 of Fig 3, while as shown in Fig. 7B, steps 34' to 42' are identical to steps 34 to 42 shown in Fig. 4A. At step 90 (Fig. 7B), if the current base station should be changed, data indicating the new base station (depicted by BS_0') is informed to the current base station together with the power control coefficient R. Otherwise, only the coefficient R is transmitted to the current base station BS_0. After step 90, the routine returns to step 22' of Fig. 7A in order to repeat the operations. On the other hand, as shown in Fig. 8, at step 92, the current base station receives the information (viz., BS_0' (if any) and R) which the mobile unit transmitted at step 90. Following this, steps 40' to 50' are implemented which are respectively identical to steps 40 to 50 of Fig. 4B.

[0029] A fifth embodiment of the present invention will be described with reference to Figs. 9A and 9B. The instant embodiment features a calculated power control coefficient (denoted by R' in step 42') is checked to determine if R' is within a predetermined range where the current base station should not be changed. For this pur-

pose, the power control coefficient R is initialized at step 100 (viz., R is set to one (1)). The following steps 22' to 40' are exactly identical to steps 22 to 40 shown in Figs. 7A and 7B. At step 42' of Fig 9B is similar to the counterport of Fig 7B. At step 102, a check is made to determine if the current base station should be changed. If the answer is negative at this step, the routine goes to step 104 at which the calculated power control coeffircient R' is checked if R' is within the predetermined range as mentioned above. If the answer at step 104 is NO, the calculated coefficient R' is adopted and then advised to the base station BS_0 at steps 106 and 108. On the other hand, if the answer at step 104 is YES, the routine proceeds to step 22' of Fig. 9A.

[0030] It will be understood that the above disclosure is representative of five possible embodiments of the present invention and that the concept on which the invention is based is not specifically limited thereto.

Claims

1. A method of controlling transmission power of at least one base station among a plurality of base stations associated with a mobile unit in a code division multiple access, CDMA, cellular system, said mobile unit communicating with said at least one base station, said method comprising the steps of:

    (a) measuring, at said mobile unit, a power value of each of a plurality of pilot signals respectively transmitted from said plurality of base stations;
    (b) determining a first power control coefficient which is a ratio of total pilot power values of said plurality of base stations, other than said at least one base station, to a pilot power value of said at least one base station; and
    (c) controlling the transmission power of said at least one base station by using said first power control coefficient.

2. A method as claimed in claim 1, wherein the power value of each of the pilot signals is compared, at said mobile unit, with a predetermined value after step (a), a power exceeding the predetermined value being selected, and the values of selected power being sent to said at least one base station and being used to determine said first power control coefficient in step (b), said first power control coefficient being used to control the transmission power in step (c).

3. A method as claimed in claim 1, wherein the power value of each of the pilot signals is compared, at said mobile unit, with a first predetermined value after step (a), a power exceeding the first predetermined value being selected, and the values of selected power being sent to said at least one base station.

4. A method as claimed in claim 3, wherein each of the values of selected power is compared, at said at least one base station, with a second predetermined value in step (c), and the power values each exceeding said second predetermined value being used to determine said first power control coefficient.

5. A method as claimed in claim 1, 2, 3 or 4, further comprising the steps of:

    receiving, at said at least one base station, total transmission power of each of said plurality of base stations from a mobile telephone switching office, MTSO, which is provided in said CDMA cellular system to supervise overall operations of the system;
    determining, at said at least one base station, a second power control coefficient which is a ratio of $(P_1Q_1 + P_2Q_2 + \dots + P_kQ_k)$ to $(Gh \cdot Pm \cdot B_0)$ where P_i (i=1, 2, ... k) is the total transmission power of an i-th base station, Q_i (i=1, 2,... k) is the power value of the pilot signal of an i-th base station other than said at least one base station, Pm is a maximum transmission power of each of the base stations, and Bo is the power value of the pilot signal of said at least one base station; and
    controlling the transmission power of said at least one base station using said second power control coefficient instead of said first power control coefficient.

6. A method of controlling transmission power of at least one base station of a plurality of base stations associated with a mobile unit in a CDMA cellular system, said mobile unit communicating with said at least one base station, said method comprising the steps of:

    (a) measuring, at said mobile unit, a first power value of a pilot signal transmitted from said at least one base station and a plurality of second power values each transmitted from said plurality of base stations other than said at least one base station;
    (b) advising said at least one base station of said first and second power values;
    (c) determining, at said at least one base station, a power control coefficient using said first and second power values; and
    (d) controlling the transmission power of said at least one base station using said power control coefficient.

7. A method as claimed in claim 6, wherein each of said first and second values is compared, at said mobile unit, with a first predetermined value after step (a), the power value exceeding said first predetermined value being selected and being sent to said at least one base station.

8. A method as claimed in claim 6 or 7, wherein each of said first and second values is compared, at said at least one base station, with a second predetermined value in step (c), and the power values exceeding said second predetermined value being used to determine said power control coefficient.

9. A method as claimed in claim 6, 7 or 8, further comprising the steps of:

receiving, at said at least one base station, total transmission power of each of said plurality of base stations from MTSO which is provided in said CDMA cellular system to supervise overall operations of the system;
determining, at said at least one base station, another power control coefficient which is a ratio of ($P_1Q_1 + P_2Q_2 + ... + P_kQ_k$) to (Gh· Pm· B_0) where P_1 (i=1, 2, ... k) is the total transmission power of an i-th base station, Q_i (i=1, 2, ... k) is the power value of the pilot signal of an i-th base station other than said at least one base station, Pm is a maximum transmission power of each of the base stations, and B_0 is the power value of pilot signal of said at least one base station; and
controlling the transmission power of said at least one base station using said another power control coefficient instead of the first-mentioned power control coefficient.

10. A method of controlling transmission power of at least one base station among a plurality of base stations associated with a mobile unit in a CDMA cellular system, said mobile unit communicating with said at least one base station, said method comprising the steps of:

(a) measuring, at said mobile unit, a first power value of a pilot signal transmitted from said at least one base station and a plurality of second power values each transmitted from said plurality of base stations other than said at least one base station;
(b) determining, at said mobile unit, a power control coefficient using said first and second power values;
(c) advising said at least one base station of said power control coefficient; and
(d) controlling the transmission power of said at least one base station using said power control coefficient.

11. A method as claimed in claim 10, wherein each of said first and second values is compared, at said mobile unit, with a predetermined value after step (a), a power value exceeding said predetermined value being selected, and the values of selected power being used to determine said power control coefficient in step (b).

12. A method as claimed in any one of claims 6 to 11, wherein said power control coefficient is a ratio of said first and second power values.

Patentansprüche

1. Verfahren zum Regeln der Sendeleistung mindestens einer Basisstation unter mehreren einer Mobileinheit zugeordneten Basisstationen in einem zellularen Codemultiplex-Vielfachzugriff (CDMA-) -System, wobei die Mobileinheit mit der mindestens einen Basisstation kommuniziert, mit den Schritten:

(a) Messen des Leistungswertes jedes von mehreren Pilotsignalen, die jeweils von den mehreren Basisstationen übertragen werden, an der Mobileinheit;
(b) Bestimmen eines ersten Leistungssteuerkoeffizienten, der ein Verhältnis der gesamten Pilotsignalleistungswerte der mehreren Basisstationen, die von der mindestens einen Basisstation verschieden sind, zu einem Pilotsignalleistungswert der mindestens einen Basisstation darstellt; und
(c) Steuern der Sendeleistung der mindestens einen Basisstation unter Verwendung des ersten Leistungssteuerkoeffizienten.

2. Verfahren nach Anspruch 1, wobei der Leistungswert jedes Pilotsignals an der Mobileinheit nach Schritt (a) mit einem vorgegebenen Wert verglichen wird, ein den vorgegebenen Wert überschreitender Leistungswert ausgewählt wird, und die ausgewählten Leistungswerte an die mindestens eine Basisstation übertragen und in Schritt (b) zum Bestimmen des ersten Leistungssteuerkoeffizienten verwendet werden, wobei der erste Leistungssteuerkoeffizient in Schritt (c) zum Steuern der Sendeleistung verwendet wird.

3. Verfahren nach Anspruch 1, wobei der Leistungswert jedes Pilotsignals an der Mobileinheit nach Schritt (a) mit einem ersten vorgegebenen Wert verglichen wird, ein den ersten vorgegebenen Wert überschreitender Leistungswert ausgewählt wird und die ausgewählten Leistungswerte an die mindestens eine Basisstation übertragen werden.

4. Verfahren nach Anspruch 3, wobei jeder der ausgewählten Leistungswerte an der mindestens einen Basisstation in Schritt (c) mit einem zweiten vorgegebenen Wert verglichen wird und wobei die den zweiten vorgegebenen Wert jeweils überschreitenden Leistungswerte zum Bestimmen des ersten Leistungssteuerkoeffizienten verwendet werden.

5. Verfahren nach Anspruch 1, 2, 3 oder 4, ferner mit den Schritten:

   Empfangen der im zellularen CDMA-System bereitgestellten Gesamtsendeleistung jeder der mehreren Basisstationen an der mindestens einen Basisstation von einer Mobilfunk-Vermittlungsstelle (MTSO), um die Gesamtoperation des Systems zu überwachen;
   Bestimmen eines zweiten Sendeleistungssteuerkoeffizienten an der mindestens einen Basisstation, der ein Verhältnis von $(P_1Q_1 + P_2Q_2 + ... + P_kQ_k)$ zu $(Gh \cdot Pm \cdot B_0)$ ist, wobei P_i (i = 1, 2, ...k) die Gesamtsendeleistung einer i-ten Basisstation, Q_i (i = 1, 2, ...k) den Leistungswert des Pilotsignals einer von der mindestens einen Basisstation verschiedenen i-ten Basistation, Pm eine maximale Sendeleistung jeder der Basisstationen und B_0 den Leistungswert des Pilotsignals der mindestens einen Basisstation bezeichnen; und
   Steuern der Sendeleistung der mindestens einen Basisstation unter Verwendung des zweiten Leistungssteuerkoeffizienten an Stelle des ersten Leistungssteuerkoeffizienten.

6. Verfahren zum Steuern der Sendeleistung mindestens einer Basisstation unter mehreren einer Mobileinheit zugeordneten Basisstationen in einem zellularen Codemultiplex-Vielfachzugriff(CDMA-)-System, wobei die Mobileinheit mit der mindestens einen Basisstation kommuniziert, mit den Schritten:

   (a) Messen eines ersten Leistungswertes eines von der mindestens einen Basisstation übertragenen Pilotsignals und mehrerer zweiter Leistungswerte, die jeweils von den mehreren Basisstationen übertragen werden, die von der mindestens einen Basisstation verschieden sind, an der Mobileinheit;
   (b) Informieren der mindestens einen Basisstation über den ersten Leistungswert und die zweiten Leistungswerte;
   (c) Bestimmen eines Leistungssteuerkoeffizienten unter Verwendung des ersten Leistungswertes und der zweiten Leistungswerte an der mindestens einen Basisstation; und
   (d) Steuern der Sendeleistung der mindestens einen Basisstation unter Verwendung des Leistungssteuerkoeffizienten.

7. Verfahren nach Anspruch 6, wobei der erste Leistungswert und die zweiten Leistungswerte an der Mobileinheit nach Schritt (a) mit einem ersten vorgegebenen Wert verglichen werden, und wobei der den ersten vorgegebenen Wert überschreitenden Leistungswert ausgewählt und an die mindestens eine Basisstation übertragen wird.

8. Verfahren nach Anspruch 6 oder 7, wobei der erste Leistungswert und die zweiten Leistungswerte an der mindestens einen Basisstation in Schritt (c) mit einem zweiten vorgegebenen Wert verglichen werden, und wobei die den zweiten vorgegebenen Wert überschreitenden Leistungswerte zum Bestimmen des Leistungssteuerkoeffizienten verwendet werden.

9. Verfahren nach Anspruch 6, 7 oder 8, ferner mit den Schritten:

   Empfangen der im zellularen CDMA-System bereitgestellten Gesamtsendeleistung jeder der mehreren Basisstationen von der Mobilfunk-Vermittlungsstelle (MTSO) an der mindestens einen Basisstation, um die Gesamtoperationen des Systems zu überwachen;
   Bestimmen eines anderen Leistungssteuerkoeffizienten an der mindestens einen Basisstation, der ein Verhältnis von $(P_1Q_1 + P_2Q_2 + ... + P_kQ_k)$ zu $(Gh \cdot Pm \cdot B_0)$ ist, wobei P_i (i = 1, 2, ... k) die Gesamtsendeleistung einer i-ten Basisstation, Q_i (i = 1, 2, ...k) den Leistungswert des Pilotsignals einer von der mindestens einen Basisstation verschiedenen i-ten Basisstation, Pm eine maximale Sendeleistung jeder der Basisstationen und B_0 den Leistungswert des Pilotsignals der mindestens einen Basisstation bezeichnen; und
   Steuern der Sendeleistung der mindestens einen Basisstation unter Verwendung des anderen Leistungssteuerkoeffizienten an Stelle des zuerst erwähnten Leistungssteuerkoeffizienten.

10. Verfahren zum Steuern der Sendeleistung mindestens einer Basisstation unter mehreren einer Mobileinheit zugeordneten Basisstationen in einem zellularen Codemultiplex-Vielfachzugriff(CDMA-)-System, wobei die Mobileinheit mit der mindestens einen Basisstation kommuniziert, mit den Schritten:

   (a) Messen eines ersten Leistungswertes eines von der mindestens einen Basisstation übertragenen Pilotsignals und mehrerer zweiter Leistungswerte, die von den mehreren Basisstationen übertragen werden, die von der mindestens einen Basisstation verschieden sind, an der Mobileinheit;

(b) Bestimmen eines Leistungssteuerkoeffizienten unter Verwendung des ersten Leistungswertes und der zweiten Leistungswerte an der Mobileinheit;
(c) Informieren der mindestens einen Basisstation über den Leistungssteuerkoeffizienten; und
(d) Steuern der Sendeleistung der mindestens einen Basisstation unter Verwendung des Leistungssteuerkoeffizienten.

11. Verfahren nach Anspruch 10, wobei der erste Leistungswert und die zweiten Leistungswerte an der Mobileinheit nach Schritt (a) mit einem vorgegebenen Wert verglichen werden und wobei die den vorgegebenen Wert überschreitenden Leistungswerte ausgewählt und in Schritt (b) zum Bestimmen des Leistungssteuerkoeffizienten verwendet werden.

12. Verfahren nach einem der Ansprüche 6 bis 11 wobei der Leistungssteuerkoeffizient ein Verhältnis zwischen dem ersten Leistungswert und den zweiten Leistungswerten ist.

Revendications

1. Procédé de commande de la puissance de transmission d'au moins une station de base parmi une pluralité de stations de base associées à une unité mobile dans un système cellulaire AMDC (accès multiple par différence de code), ladite unité mobile communiquant avec ladite au moins une station de base, ledit procédé comprenant les étapes:

   (a) mesurer, au niveau de ladite unité mobile, une valeur de puissance de chaque signal pilote d'une pluralité de signaux pilotes respectivement transmis par ladite pluralité de stations de base ;
   (b) déterminer un premier coefficient de commande de puissance qui est un rapport de valeurs totales de puissance de signal pilote de ladite pluralité de stations de base, autres que ladite au moins une station de base, sur une valeur de puissance de signal pilote de ladite au moins une station de base ; et
   (c) commander la puissance de transmission de ladite au moins une station de base en utilisant ledit premier coefficient de commande de puissance.

2. Procédé selon le revendication 1, dans lequel la valeur de puissance de chacun des signaux pilotes est comparée, au niveau de ladite unité mobile, avec une valeur prédéterminée après l'étape (a), une puissance dépassant le valeur prédéterminée étant sélectionnée, et les valeurs de la puissance sélectionnée étant envoyées à ladite au moins une station de base et utilisées pour déterminer ledit premier coefficient de commande de puissance à l'étape (b), ledit premier coefficient de commande de puissance étant utilisé pour commander la puissance de transmission à l'étape (c)

3. Procédé selon le revendication 1, dans lequel la valeur de puissance de chacun des signaux pilotes est comparée, au niveau de ladite unité mobile, avec une première valeur prédéterminée après l'étape (a), une puissance dépassant la première valeur prédéterminée étant sélectionnée, et les valeurs de la puissance sélectionnée étant envoyées à ladite au moins une station de base.

4. Procédé selon le revendication 3, dans lequel chacune des valeurs de la puissance sélectionnée est comparée, au niveau de ladite au moins une station de base, avec une deuxième valeur prédéterminée à l'étape (c), et les valeurs de puissance dépassant ladite deuxième valeur prédéterminée étant utilisées pour déterminer ledit premier coefficient de commande de puissance.

5. Procédé selon la revendication 1, 2, 3 ou 4, comprenant en outre les étapes:

   recevoir, au niveau de ladite au moins une station de base, le puissance de transmission totale de chaque station de base de ladite pluralité de stations de base provenant d'un centre de commutation pour téléphonie mobile (MTSO), qui se situe dans ledit système cellulaire AMDC pour superviser l'ensemble des opérations du système ;
   déterminer, au niveau de ladite au moins une station de base, un deuxième coefficient de commande de puissance qui est un rapport de $(P_1Q_1 + P_2Q_2 + ... + P_kQ_k)$ sur $(Gh \bullet Pm \bullet B_0)$ où P_i (i = 1, 2, ...k) est le puissance de transmission totale d'une $i^{ème}$ station de base, Q_i (i = 1, 2, ... k) est le valeur de puissance du signal pilote d'une $i^{ème}$ station de base autre que ladite au moins une station de base, Pm est une puissance de transmission maximale de chacune des stations de base, et B_0 est la valeur de puissance du signal pilote de ladite au moins une station de base ; et
   commander la puissance de transmission de ladite au moins une station de base en utilisant ledit deuxième coefficient de commande de puissance à la place dudit premier coefficient de commande de puissance.

6. Procédé de commande de puissance de transmission d'au moins une station de base d'une pluralité de stations de base associées à une unité mobile

dans un système cellule AMDC, ladite unité mobile communiquant avec ladite au moins une station de base, ledit procédé comprenant les étapes:

(a) mesurer, au niveau de ladite unité mobile, une première valeur de puissance d'un signal pilote transmis par ladite au moins une station de base et une pluralité de deuxièmes valeurs de puissance transmises chacune par ladite pluralité de stations de base autres que ladite au moins une station de base ;
(b) aviser ladite au moins une station de base desdites premières et deuxièmes valeurs de puissance ;
(c) déterminer, au niveau de ladite au moins une station de base, un coefficient de commande de puissance en utilisant lesdites premières et deuxièmes valeurs de puissance ; et
(d) commander la puissance de transmission de ladite au moins une station de base en utilisant ledit coefficient de commande de puissance.

7. Procédé selon la revendication 6, dans lequel chacune desdites premières et deuxièmes valeurs est comparée, au niveau de ladite unité mobile, avec une première valeur prédéterminée après l'étape (a), la valeur de puissance dépassant ladite première valeur prédéterminée étant sélectionnée et envoyée à ladite au moins une station de base.

8. Procédé selon la revendication 6 ou 7, dans lequel chacune desdites premières et deuxièmes valeurs est comparée, au niveau de ladite au moins une station de base, avec une deuxième valeur prédéterminée à l'étape (c), et les valeurs de puissance dépassant ladite deuxième valeur prédéterminée étant utilisées pour déterminer ledit coefficient de commande de puissance.

9. Procédé selon la revendication 6, 7 ou 8, comprenant en outre les étapes:

recevoir, au niveau de ladite au moins une station de base, la puissance de transmission totale de chaque station de base de ladite pluralité de stations de base provenant d'un MTSO, qui se situe dans ledit système cellulaire AMDC pour superviser l'ensemble des opérations du système ;
déterminer, au niveau de ladite au moins une station de base, un autre coefficient de commande de puissance qui est un rapport de $(P_1Q_1 + P_2Q_2 + ... + P_kQ_k)$ sur $(Gh \cdot Pm \cdot B_0)$ où P_i (i = 1, 2, ...k) est la puissance de liaison totale d'une i^{ème} station de base, Q_i (i = 1, 2, ... k) est la valeur de puissance du signal pilote d'une i^{ème} station de base autre que ladite au moins une station de base, Pm est une puissance de transmission maximale de chacune des stations de base, et B_0 est la valeur de puissance du signal pilote de ladite au moins une station de base ; et
commander la puissance de transmission de ladite au moins une station de base en utilisant ledit autre coefficient de commande de puissance à la place dudit coefficient de commande de puissance cité en premier.

10. Procédé de commande de puissance de transmission d'au moins une station de base d'une pluralité de stations de base associées à une unité mobile dans un système cellule AMDC, ladite unité mobile communiquant avec ladite au moins une station de base, ledit procédé comprenant les étapes:

(a) mesurer, au niveau de ladite unité mobile, une première valeur de puissance d'un signal pilote transmis par ladite au moins une station de base et une pluralité de deuxièmes valeurs de puissance transmises chacune par ladite pluralité de stations de base autres que ladite au moins une station de base ;
(b) déterminer, au niveau de ladite unité mobile, un coefficient de commande de puissance en utilisant lesdites premières et deuxièmes valeurs de puissance ;
(c) aviser ladite au moins une station de base dudit coefficient de commande de puissance ; et
(d) commander la puissance de transmission de ladite au moins une station de base en utilisant ledit coefficient de commande de puissance.

11. Procédé selon la revendication 10, dans lequel chacune desdites premières et deuxièmes valeurs est comparée, au niveau de ladite unité mobile, avec une valeur prédéterminée après l'étape (a), une valeur de puissance dépassant ladite valeur prédéterminée étant sélectionnée, et les valeurs de la puissance sélectionnée étant utilisées pour déterminer ledit coefficient de commande de puissance à l'étape (b).

12. Procédé selon l'une quelconque des revendications 6 à 11, dans lequel ledit coefficient de commande de puissance est un rapport desdites premières et deuxièmes valeurs de puissance.

FIG. 1

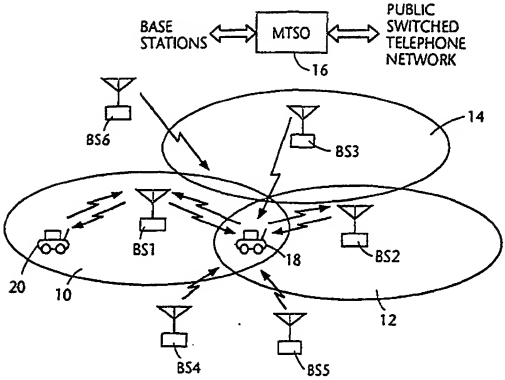

BASE STATIONS
MTSO
PUBLIC SWITCHED TELEPHONE NETWORK
16
14
BS6
BS3
BS1
BS2
18
20
10
12
BS4
BS5

FIG. 2

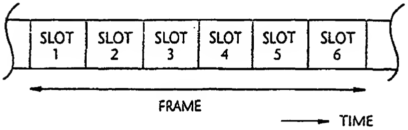

SLOT 1
SLOT 2
SLOT 3
SLOT 4
SLOT 5
SLOT 6
FRAME
TIME

FIG. 3

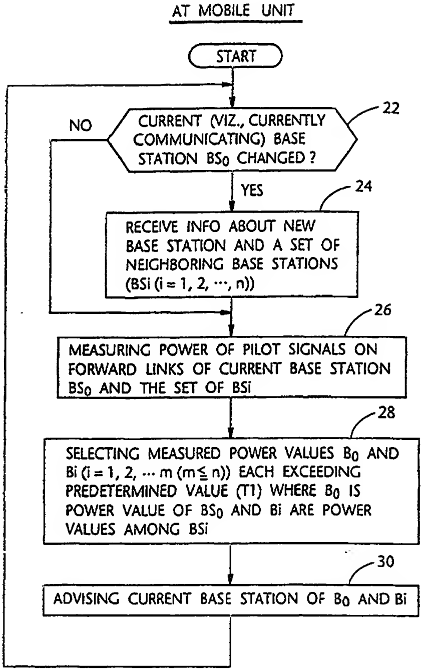

AT MOBILE UNIT
START
CURRENT (VIZ., CURRENTLY COMMUNICATING) BASE STATION BS_0 CHANGED ?
22
NO
YES
24
RECEIVE INFO ABOUT NEW BASE STATION AND A SET OF NEIGHBORING BASE STATIONS (BSi (i = 1, 2, ···, n))
26
MEASURING POWER OF PILOT SIGNALS ON FORWARD LINKS OF CURRENT BASE STATION BS_0 AND THE SET OF BSi
28
SELECTING MEASURED POWER VALUES B_0 AND Bi (i = 1, 2, ··· m (m ≦ n)) EACH EXCEEDING PREDETERMINED VALUE (T1) WHERE B_0 IS POWER VALUE OF BS_0 AND Bi ARE POWER VALUES AMONG BSi
30
ADVISING CURRENT BASE STATION OF B_0 AND Bi

FIG. 4A

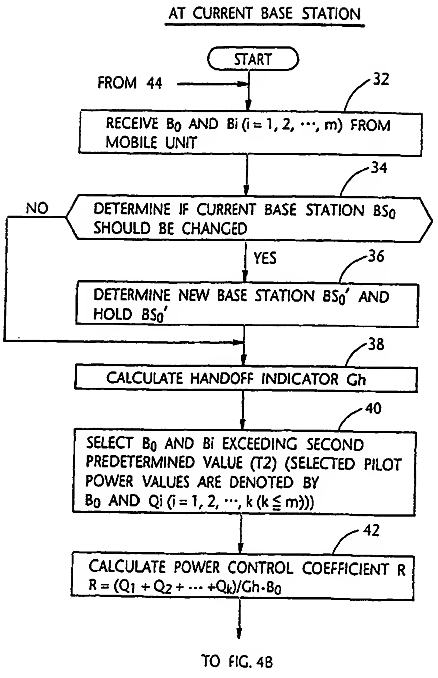

AT CURRENT BASE STATION
START
FROM 44
32
RECEIVE B_0 AND Bi (i = 1, 2, ···, m) FROM MOBILE UNIT
34
NO
DETERMINE IF CURRENT BASE STATION BS_0 SHOULD BE CHANGED
YES
36
DETERMINE NEW BASE STATION BS_0' AND HOLD BS_0'
38
CALCULATE HANDOFF INDICATOR Gh
40
SELECT B_0 AND Bi EXCEEDING SECOND PREDETERMINED VALUE (T2) (SELECTED PILOT POWER VALUES ARE DENOTED BY B_0 AND Qi (i = 1, 2, ···, k (k ≦ m)))
42
CALCULATE POWER CONTROL COEFFICIENT R
$R = (Q_1 + Q_2 + \cdots + Q_k)/Gh \cdot B_0$
TO FIG. 4B

FIG. 4B

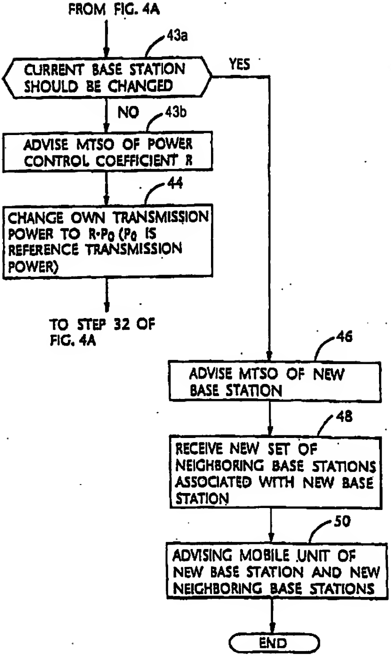

FROM FIG. 4A
43a
CURRENT BASE STATION SHOULD BE CHANGED
YES
NO
43b
ADVISE MTSO OF POWER CONTROL COEFFICIENT R
44
CHANGE OWN TRANSMISSION POWER TO R·P0 (P0 IS REFERENCE TRANSMISSION POWER)
TO STEP 32 OF FIG. 4A
46
ADVISE MTSO OF NEW BASE STATION
48
RECEIVE NEW SET OF NEIGHBORING BASE STATIONS ASSOCIATED WITH NEW BASE STATION
50
ADVISING MOBILE UNIT OF NEW BASE STATION AND NEW NEIGHBORING BASE STATIONS
END

FIG. 5A

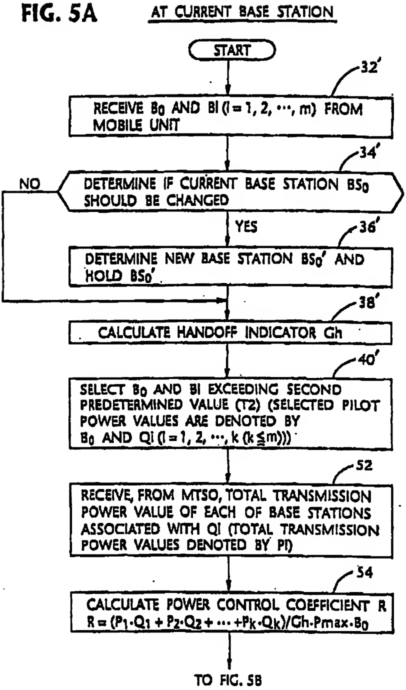

AT CURRENT BASE STATION
START
32'
RECEIVE B0 AND Bl (l = 1, 2, ···, m) FROM MOBILE UNIT
34'
DETERMINE IF CURRENT BASE STATION BS0 SHOULD BE CHANGED
NO
YES
36'
DETERMINE NEW BASE STATION BS0' AND HOLD BS0'.
38'
CALCULATE HANDOFF INDICATOR Gh
40'
SELECT B0 AND Bl EXCEEDING SECOND PREDETERMINED VALUE (T2) (SELECTED PILOT POWER VALUES ARE DENOTED BY B0 AND Ql (l = 1, 2, ···, k (k ≦ m)))
52
RECEIVE, FROM MTSO, TOTAL TRANSMISSION POWER VALUE OF EACH OF BASE STATIONS ASSOCIATED WITH Ql (TOTAL TRANSMISSION POWER VALUES DENOTED BY Pl)
54
CALCULATE POWER CONTROL COEFFICIENT R
R = (P1·Q1 + P2·Q2 + ··· +Pk·Qk)/Gh·Pmax·B0
TO FIG. 5B

FIG. 5B

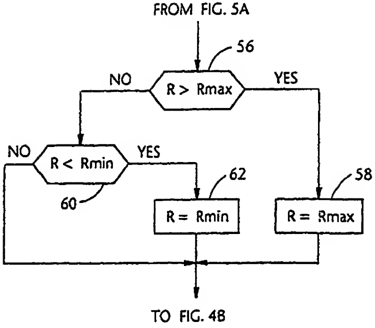

FROM FIG. 5A
56
NO
R > Rmax
YES
NO
R < Rmin
YES
62
58
60
R = Rmin
R = Rmax
TO FIG. 4B

FIG. 6

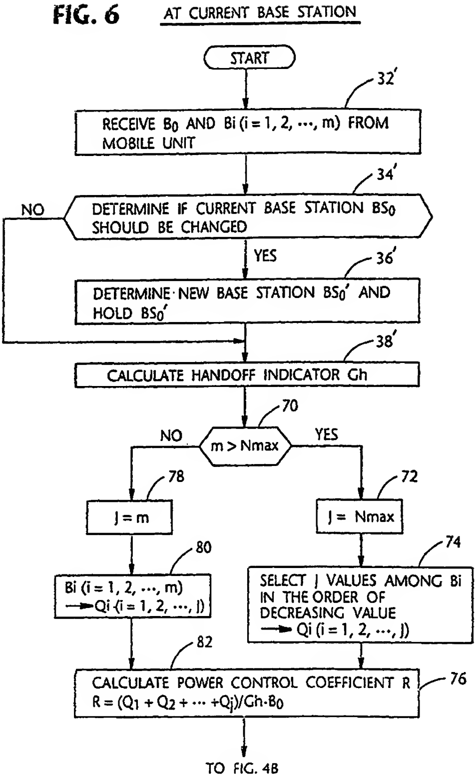

AT CURRENT BASE STATION
START
32'
RECEIVE B0 AND Bi (i = 1, 2, ..., m) FROM MOBILE UNIT
34'
NO
DETERMINE IF CURRENT BASE STATION BS0 SHOULD BE CHANGED
YES
36'
DETERMINE NEW BASE STATION BS0' AND HOLD BS0'
38'
CALCULATE HANDOFF INDICATOR Gh
70
NO
m > Nmax
YES
78
J = m
72
J = Nmax
80
Bi (i = 1, 2, ..., m) → Qi (i = 1, 2, ..., J)
74
SELECT J VALUES AMONG Bi IN THE ORDER OF DECREASING VALUE → Qi (i = 1, 2, ..., J)
82
CALCULATE POWER CONTROL COEFFICIENT R
R = (Q1 + Q2 + ... +Qj)/Gh·B0
76
TO FIG. 4B

FIG. 7A

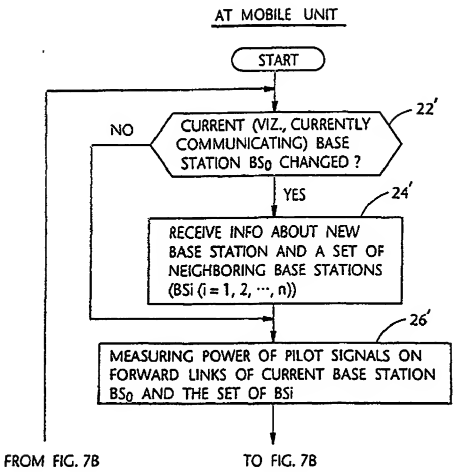

AT MOBILE UNIT
START
22'
NO
CURRENT (VIZ., CURRENTLY COMMUNICATING) BASE STATION BS_0 CHANGED ?
YES
24'
RECEIVE INFO ABOUT NEW BASE STATION AND A SET OF NEIGHBORING BASE STATIONS (BSi (i = 1, 2, ···, n))
26'
MEASURING POWER OF PILOT SIGNALS ON FORWARD LINKS OF CURRENT BASE STATION BS_0 AND THE SET OF BSi
FROM FIG. 7B
TO FIG. 7B

FIG. 7B

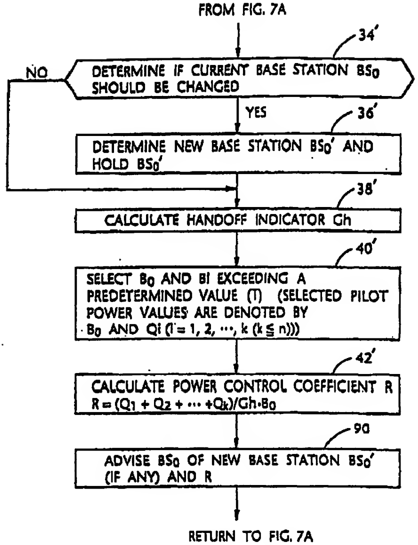

FROM FIG. 7A
34'
NO
DETERMINE IF CURRENT BASE STATION BS_0 SHOULD BE CHANGED
YES
36'
DETERMINE NEW BASE STATION BS_0' AND HOLD BS_0'
38'
CALCULATE HANDOFF INDICATOR Gh
40'
SELECT B_0 AND BI EXCEEDING A PREDETERMINED VALUE (T) (SELECTED PILOT POWER VALUES ARE DENOTED BY B_0 AND Qi ($i = 1, 2, \cdots, k$ ($k \leq n$)))
42'
CALCULATE POWER CONTROL COEFFICIENT R
$R = (Q_1 + Q_2 + \cdots + Q_k)/Gh \cdot B_0$
90
ADVISE BS_0 OF NEW BASE STATION BS_0' (IF ANY) AND R
RETURN TO FIG. 7A

FIG. 8

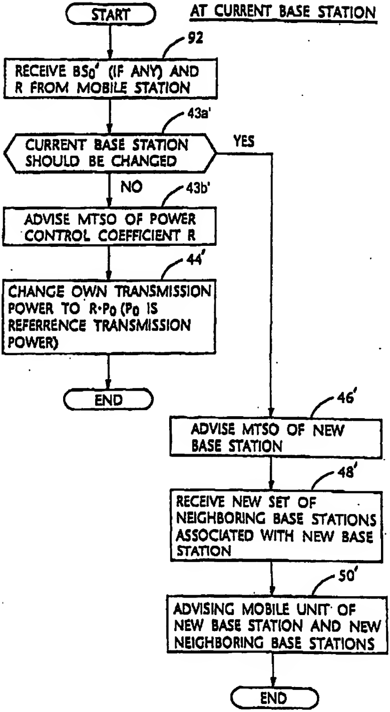

AT CURRENT BASE STATION
START
92
RECEIVE BS0' (IF ANY) AND R FROM MOBILE STATION
43a'
CURRENT BASE STATION SHOULD BE CHANGED
YES
NO
43b'
ADVISE MTSO OF POWER CONTROL COEFFICIENT R
44'
CHANGE OWN TRANSMISSION POWER TO R·P0 (P0 IS REFERRENCE TRANSMISSION POWER)
END
46'
ADVISE MTSO OF NEW BASE STATION
48'
RECEIVE NEW SET OF NEIGHBORING BASE STATIONS ASSOCIATED WITH NEW BASE STATION
50'
ADVISING MOBILE UNIT OF NEW BASE STATION AND NEW NEIGHBORING BASE STATIONS
END

FIG. 9A

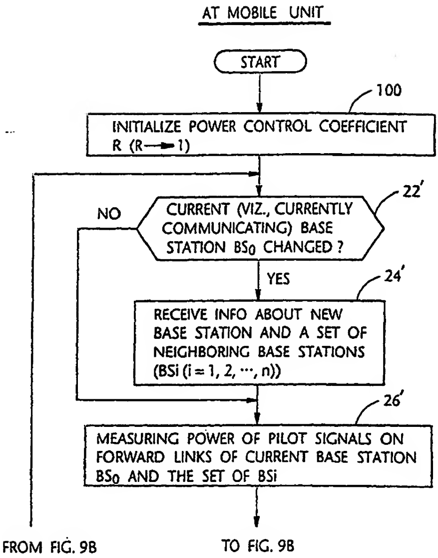
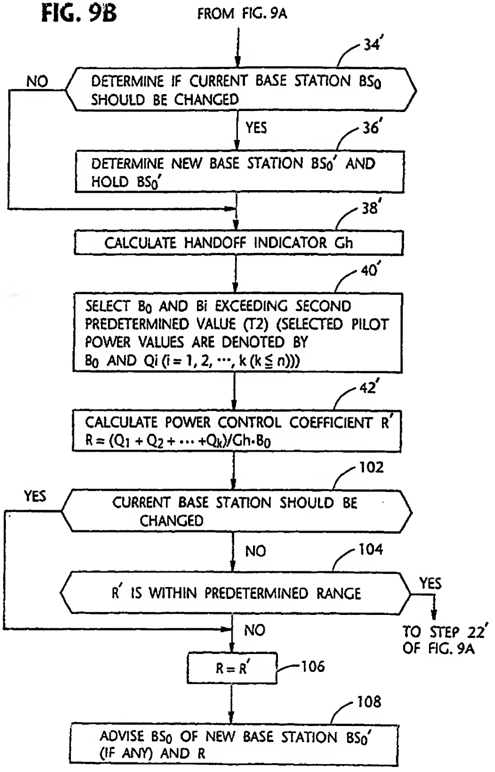

AT MOBILE UNIT
START
100
INITIALIZE POWER CONTROL COEFFICIENT R (R→1)
22'
NO
CURRENT (VIZ., CURRENTLY COMMUNICATING) BASE STATION BS0 CHANGED ?
YES
24'
RECEIVE INFO ABOUT NEW BASE STATION AND A SET OF NEIGHBORING BASE STATIONS (BSi (i = 1, 2, ···, n))
26'
MEASURING POWER OF PILOT SIGNALS ON FORWARD LINKS OF CURRENT BASE STATION BS0 AND THE SET OF BSi
FROM FIG. 9B
TO FIG. 9B

FIG. 9B


FROM FIG. 9A
34'
NO
DETERMINE IF CURRENT BASE STATION BS_0 SHOULD BE CHANGED
YES
36'
DETERMINE NEW BASE STATION BS_0' AND HOLD BS_0'
38'
CALCULATE HANDOFF INDICATOR Gh
40'
SELECT B_0 AND Bi EXCEEDING SECOND PREDETERMINED VALUE (T2) (SELECTED PILOT POWER VALUES ARE DENOTED BY B_0 AND Q_i $(i = 1, 2, \cdots, k\ (k \leqq n))$)
42'
CALCULATE POWER CONTROL COEFFICIENT R'
$R = (Q_1 + Q_2 + \cdots + Q_k)/Gh \cdot B_0$
102
YES
CURRENT BASE STATION SHOULD BE CHANGED
NO
104
R' IS WITHIN PREDETERMINED RANGE
YES
TO STEP 22' OF FIG. 9A
NO
R = R'
106
108
ADVISE BS_0 OF NEW BASE STATION BS_0' (IF ANY) AND R